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By these means an exact matching of colors (as they appear to the color-blind eye) can be made, either between red and green, or between red or green and gray. Besides showing the presence of complete red-green blindness, it also distinguishes the "red-blind" from the "green-blind" forms of red-green blindness, in Hering's words, the "*relativ blausichtiger Rothgrünblinder*" from the "*relativ Gelbsichtiger*." It also seems capable of adaptation to other types of visual disturbance, some description of its application to which the author may publish on another occasion.

Die Untersuchung einseitiger Störungen des Farbensinnes mittels binocularer Farbengleichungen. E. HERING. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 1-23.

Of great interest for the theory of color vision are those cases in which color-blindness is confined to a single eye. In order, however, to yield the most exact and valuable results, the patient must not be asked to describe the colors of things seen, for this he often does inaccurately, but to match the colors seen with his color-blind eye alone with those seen at the same time with his normal eye alone. This is possible if an area of color is so presented to each eye that the one seen by the right eye is wholly invisible to the left eye, and *vice versa*, and if the two areas lie upon disparate retinal points, (e. g., on the temporal halves of the eyes), and thus escape binocular combination. Under such circumstances, very delicate comparison of colors is possible. Under the title given above, Hering describes (with one illustration) an instrument for testing such cases, and reports the result of an application of it in the case of a woman whose vision on the right side was reduced by atrophy of the optic nerve to about one-half the normal acuteness, with marked disturbance of vision for colors. The tests showed that all colors appeared more whitish or grayish to the color-blind than to the normal eye; yellow and blue did not suffer any noticeable change in their color-tone; unsaturated primary red and green (Hering's *Urroth* and *Urgrün*) appeared colorless; the intermediate colors tried, (red of spectral tone, orange, yellow-green, and unsaturated violet), lost their red or green character entirely, and appeared whitish or grayish yellow or blue; white, gray and black were for both eyes the same. The red-green vision of the patient was, therefore, nearly destroyed, the blue-yellow vision much weakened. Other tests with spectral colors gave concurrent results. Tests of the acuteness of the patient's peripheral color-vision showed the color fields reduced in size; and careful tests of the same (made later) with the color-mixer, showed that the limits of the field for the members of each color pair were the same; red and green 5°, blue and yellow 30°. Still other tests showed that colors which matched for the sound eye, also matched (*i. e.*, both suffered equal change) for the defective eye. It is hardly necessary to say that these facts speak strongly for Hering's four-color theory and against the three-color theory of Helmholtz.

Untersuchung eines Falles von halbseitiger Farbensinnsstörung am linken Auge. C. HESS. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 24-36.

In the case of monocular color-blindness examined by Hess, the defect was still more limited than in Hering's case, occupying, indeed, only the nasal half of one retina. The patient was a man of about thirty years and near-sighted. The sharpness of vision in the affected eye (both supplied with proper glasses) was about one-half that of the other. The colors to be matched were this time presented, one to the nasal, the other to the temporal half of the single eye. Tests with pigment colors, homogeneous spectral lights and the perimeter gave results not essentially

different from those of Hering. In this case, however, the disturbance was apparently more serious, for the red and green of the perimetrical tests could not be seen on any part of the diseased half-retina, and the sensitiveness to white light was a little less than normal. The case, of course, justifies the same conclusions as Hering's above. In both cases a condition of things has been brought about on the central parts of the retina by disease, which exactly corresponds with that on the more peripheral parts of the normal eye.

The Knee-jerk and its Physiological Modifications. By Prof. H. P. BOWDITCH and Dr. J. W. WARREN. *Journal of Physiology*, XI, 1890, 25-64.

It has been known for some time that muscular contractions and various sensory and other conditions affecting the central nervous system could considerably re-inforce the knee-jerk, also that the re-inforcing contraction must precede the stroke upon the tendon by a certain interval. To the study of this point the experiments of the present paper were directed. The apparatus was somewhat complicated, but is marked by the clever devices common to Dr. Bowditch's laboratory, and is fully described. The general results may be summarized somewhat as follows: A voluntary muscular contraction (in response, after the manner of reaction-times, to a bell-stroke) increases the knee-jerk, if the blow on the ligament falls at the time of the contraction, and in lessening degree if it follow within 0.22-0.6 sec. A larger interval than this resulted in eight cases in a decrease of the knee-jerk below its normal amount, to which, however, it returned as the interval was extended to 1.7-2.5 secs. In 2 cases there was no such negative phase. In the majority of cases, therefore, contraction of the arm muscles produces for a short time a state of increased excitability in the part of the spinal cord that mediates the knee-jerk, followed in turn by a short period of decreased excitability. Sensory re-inforcements were investigated, by the explosion of torpedoes, the flashing of light into the eyes, a blast of air on the conjunctiva, on the nasal mucous membrane, on the neck, and on the knee. These experiments were tried on fewer subjects than the motor re-inforcements (3 or less) and the individual differences are marked. With a portion of the subjects there is a positive phase but hardly any negative, while in one both phases are plainly marked. The experiments were monotonous and in some the subject fell asleep. Oncoming drowsiness decreases the extent of both normal and re-inforced knee-jerks, and sound sleep abolishes them, an effect the opposite of that produced by the same conditions upon the superficial reflexes. The authors make the interesting suggestion that the individual variations in the activities of the central nervous system which their experiments show may open the way to an understanding of those general psycho-physic modes of response vaguely known as temperaments.

Zur Messung der Reactionszeit. OTTO DUMREICHER. Inaug. Diss., Strassburg, 1889.

Twenty-one pages of this dissertation are devoted to a historical résumé of "personal equation" and reaction-time studies, in particular of those among the latter where the stimulus used was electrical and applied to the skin. Another considerable section is devoted to the description of the apparatus used, which included several ingenious devices of Ewald's—among the rest a new chronoscope, and a reaction key which is so arranged that the stimulus can be applied to the tip of the finger with which the reaction is made. The chronoscope, which is a very promising instrument, consists essentially of an electro-magnet, the armature of which works upon a toothed wheel connected with a pointer moving over a dial. If, now, a tuning-fork interrupter is intro-